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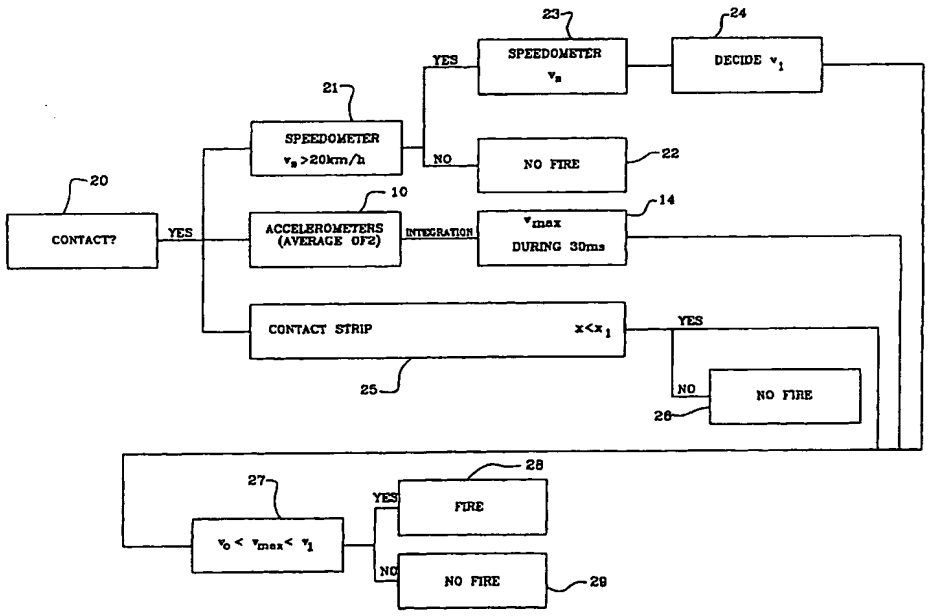
(54) Title: A DETECTOR FOR A SAFETY ARRANGEMENT



(57) Abstract: A detector is provided for a safety arrangement in a motor vehicle adapted to detect an impact between the bumper or fender (4) of the vehicle, and an object (7) such as a pedestrian. The detector arrangement includes a sensor, such as two accelerometers (8, 9) which sense the acceleration of the bumper or fender. The calculator (10, 11, 12, 13, 14) analyses the sensed acceleration to determine if the sensed acceleration is below a predetermined value. A signal generator (15) generates a signal to trigger the safety device if the acceleration is below the first predetermined value.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

"A DETECTOR FOR A SAFETY ARRANGEMENT"

THE PRESENT INVENTION relates to a detector for a safety arrangement in a motor vehicle and more particularly relates to a detector for a safety arrangement of the type which is deployed in response to an impact between the front part of the vehicle, typically a bumper or fender, and an object in the path of the vehicle, such as a pedestrian.

Various safety devices of this type have been proposed before. In some devices the bonnet or hood of the vehicle is lifted slightly to enable the pedestrian to deform the bonnet or hood with a relatively gradual deceleration of the pedestrian so that the risk of injury is minimised. In other devices air-bags or inflatable elements are deployed on the exterior of the vehicle.

A problem with devices of this type is that the sensors presently utilised are not capable of distinguishing between an impact with a pedestrian and an impact with a fixed object such as a pole or post, or even an impact with another vehicle.

The present invention seeks to provide an improved detector for a safety arrangement.

According to this invention there is provided a detector for a safety arrangement in a motor vehicle and adapted to detect an impact between the bumper or fender of the vehicle and another object, the detector comprising a sensor to determine a parameter related to the speed of at least part of the bumper or fender, and a signal generator to generate a triggering signal for the safety device if the parameter related to speed is below a first predetermined value. The speed of at least part of the bumper or fender may be measured relative to the chassis of the vehicle. The parameter related to speed may be simply speed, or may be some derivative of speed such as an increase in speed, or even relative increase, or decrease, in speed.

Preferably the bumper or fender is provided at least one said sensor in the form of an accelerometer to provide a signal representative of the acceleration of the bumper or fender.

Conveniently two said accelerometers are provided, and averaging means are provided to determine the mean acceleration as measured by the two accelerometers from which the parameter related to speed is derived

Preferably the parameter related to speed of the bumper is calculated as an integral of the signal from the accelerometer or averaging means.

Conveniently the parameter related to speed which is compared with the first predetermined value is the maximum speed that is measured during a predetermined period of time following the sensing of an impact.

In one embodiment the parameter related to speed which is compared with the first predetermined value is the speed that is measured at the end of a predetermined period of time following the sensing of an impact.

Preferably the said predetermined period of time is approximately 30 ms.

Conveniently the triggering signal is generated when the parameter related to speed value is below the first predetermined value, but above a second predetermined value.

Preferably the first predetermined value is dependent upon the instantaneous measured speed of the vehicle, there being means to determine the speed of the vehicle, and to calculate the first predetermined value from the determined vehicle speed.

Conveniently there are means to determine the speed of the vehicle and to inhibit generation of the triggering signal if the vehicle speed is below a predetermined value.

Preferably the predetermined speed value is 20 km/h.

In one embodiment the bumper or fender is provided with a contact strip sensitive to impact with an object to generate a contact signal to initiate operation of the signal generator.

Preferably the contact strip is responsive to the width of the part of an impacting object contacting the contact strip, and the detector is such that if the

width of the object exceeds a predetermined threshold, generation of the triggering signal is inhibited.

Alternatively the detector incorporates a calculator to determine the parameter related to speed by calculating the integral of the acceleration of the bumper or fender relative to the acceleration of the vehicle.

Preferably the bumper has a said sensor in the form of an accelerometer and the vehicle has an accelerometer, the outputs of the accelerometers being subtracted and integrated.

Alternatively the bumper has a said sensor in the form of an accelerometer and a memory to store the instantaneous acceleration which is fixed in the event of an impact, the outputs of the accelerometer and the memory being subtracted and integrated.

In another alternative embodiment the parameter related to speed is derived from a sensor responsive to the relative speed between the bumper or fender and the chassis of the vehicle.

In order that the invention may be more readily understood and so that further features thereof may be appreciated, the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a partially sectional and partially diagrammatic illustration of a detector for a safety arrangement incorporating the invention, and

FIGURE 2 is a block diagram provided for purposes of explanation.

Referring initially to Figure 1 a detector arrangement is shown on a motor vehicle. Part of the chassis 1 of the vehicle is shown, with the chassis supporting a front beam 2 which extends transversely across the front of the vehicle and forms part of the bumper or fender 3. The beam 2 supports an inner core 4 of the bumper formed of a foamed resilient material, and an outer bumper covering 5. Mounted between the outer covering 5 and the foam core is a contact strip 6 which is adapted to sense contact between the exterior of the bumper or fender 3 and, for example, a pedestrian 7, and to provide a contact signal. The contact strip 6 is adapted to distinguish and measure the width x of an objection, such as the pedestrian 7, which comes into contact with the bumper or fender, and in this embodiment is adapted to generate a specific signal if an object which has a width less than a predetermined width impacts with the bumper or fender 3. The contact strip 6 may thus be divided into discrete zones, each providing a contact signal when in contact with an object, the number of zones providing a signal at one instant giving an approximate indication as to the width of the object. Alternatively, the resistance of the contact path established when an object impacts with the bumper may be related to the width of the object.

Associated with the beam 2 of the bumper or fender 3 are two sensors in the form of accelerometers 8, 9, which are located respectively to the left of, and to the right of, the central axis of the vehicle. The accelerometers are adapted and configured to sense the acceleration of the bumper or fender, and may, in alternative embodiments, be located to the front of the bumper or fender, thus being located between the contact strip 6 and the foam core 4. In some embodiments of the invention, only one accelerometer or more than two accelerometers may be provided.

In the described embodiment the accelerometers 8 and 9 each provide a respective output signal, with the respective output signals being forwarded to an averaging circuit 10, which determines the average or mean acceleration of the bumper or fender as sensed by the accelerometers.

In the described embodiment, the averaged acceleration signal from the averaging circuit 10 is forwarded to a subtraction circuit 11 which also receives an input from a further accelerometer 12, with the further accelerometer 12 being mounted on the chassis of the vehicle. The output of the subtraction circuit 11, is therefore, a signal which is representative of the acceleration of the bumper or fender 3 relative to the vehicle.

In an alternative embodiment the subtraction circuit 11 and the associated accelerometer 12 may be omitted so that a signal is passed which is a measure of the absolute acceleration of the bumper or fender 4 as measured by the accelerometer.

In another arrangement the accelerometers associated with the bumper or fender 3 provide an output to a memory which stores the instantaneous value. In the event of an impact with the bumper or fender this value is stored and is subtracted from the subsequent signals from the accelerometers, which provides a signal related to the acceleration of the bumper or fender relative to the initial acceleration of the vehicle.

In another arrangement a sensor senses the acceleration of the bumper relative to the main part of the vehicle.

In either event, the measured acceleration signal is passed to an integration circuit 13 which integrates the acceleration signal with respect to

time, thus producing a speed or velocity signal v. The speed or velocity signal v is passed to a discriminator 14. The discriminator 14 in the described embodiment of the invention is adapted to determine the maximum change of speed or velocity v_{max} appearing during a predetermined period of time which, in the described embodiment is 30 ms. In alternative embodiments the discriminator may be adapted to determine speed at a predetermined instant following the initial sensing of an object such as the object 7 by the contact strip 6. This period of time may again be 30 ms.

The output of the discriminator 14 is passed to a control circuit 15, the functioning of which will be described in greater detail with reference to Figure 2, but it should be understood at this stage that the contact signal from the contact strip 6 is also passed to the control circuit 15. The control circuit 15 is also connected to receive a signal from a speedometer 16 which indicates the instantaneous speed of the vehicle.

The control circuit 15 acts as a signal generator and the output signal of the control circuit 15 is passed to a triggering unit 17 which is adapted to trigger the deployment of a safety device of the general type discussed above, such as a safety device adapted to lift the bonnet or hood of the vehicle.

The control circuit 15 is configured to control the triggering unit 17 by utilising predetermined logic. The logic process commences when an object, such as the object 7 is sensed to be in contact with the contact strip 6, as shown at box 20 in Figure 2.

If contact is sensed, the first step in the logic process is to determine the speed or velocity v_s as measured by the speedometer 16, and to determine, as shown at box 21, if the instantaneous speed v_s is in excess of a predetermined

threshold, such as a threshold of 20 km/h. If the speed is less than the threshold, then a positive decision is taken that the triggering unit 17 will not fire, as shown at box 22. At speeds of less than 20km/h the risk of injury to a pedestrian is minimal, and there is no real advantage in deploying the safety device. Thus, regardless of anything else, if the speed is less than the threshold speed, at the instant of impact with a pedestrian, the triggering unit 17 will not fire to deploy the safety device.

If the speed is greater than the threshold as shown at box 21, then, as shown at 24, a predetermined reference velocity v_1 is determined, which is dependent upon the measured speed or velocity speed v_s measured at box 23 by the speedometer, and the reference velocity v_1 is to be used at a subsequent step in the logic process.

After contact has been sensed, the signal from the averaging circuit 10, which averages the outputs of the accelerometer is integrated and discriminated, as described above, and the output v_{max} of the discriminator circuit 14 is used at a subsequent step in the logic process.

When contact is sensed, as shown at box 25, the width x of the contact strip contacted is compared with a threshold x_1. If the threshold x_1 is exceeded, then a decision is taken as shown at box 26 not to fire the triggering unit 17, and thus the safety device will not deployed. Thus, if the impact is with a very wide object, such as another vehicle, which has a width greater than the typical width of a pedestrian, then deployment of the safety device is inhibited. However, if the sensed width of the contacted area of the contact strip is less than the threshold x_1, then the logic process continues towards the making of a final decision to fire the triggering unit 17 to deploy the safety device.

As shown at box 27 the discriminated value of speed or velocity v_{max} obtained from the discriminator circuit 14 is analysed, and if that discriminated velocity value v_{max} is greater than a first predetermined fixed reference value v_o, and less than the reference value v_1 determined at box 24 in the logic process, then a decision is made to fire the triggering unit 17 to deploy the safety device, as shown at box 28. However, if the discriminated speed or velocity value v_{max} does not meet this criterion, then a decision is taken as shown at box 29 to inhibit firing of the triggering unit 17 and thus the safety device is not deployed. This helps to prevent inappropriate deployment of the safety device in the event of an impact with an object which is more rigid than a pedestrian, such as a bollard, or an object which is not as rigid as a pedestrian, such as a bush.

The first predetermined reference value v_o us selected to be below the value of v_{max} anticipated to arise in all accidents involving frontal impact with a pedestrian at speeds in excess of a selected threshold, such as 20 km/h. Thus v_o may be selected to be 0.1 m/s.

For each speed or velocity v_s of the vehicle in excess of the threshold, a predetermined reference velocity v_1 is determined as shown at 24. An appropriate algorithm or formula may be used, or there may be a "look up table". The reference velocity v_1 at any specific vehicle speed v_s is selected to be between the highest v_{max} that could be anticipated for an accident with a pedestrian and the lowest v_{max} that could be anticipated for an accident involving a fixed object such as a pole, tree or bollard. Thus, for example, $v_1 = 0.5$ ms for $v_s = 20$ km/h, $v_1 = 1.0$ m/s for $v_s = 25$ km/h and $v_1 = 1.2$ m/s for $v_s = 30$ km/h.

In the present Specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

CLAIMS:

1. A detector for a safety arrangement in a motor vehicle and adapted to detect an impact between the bumper or fender of the vehicle and another object, the detector comprising a sensor to determine a parameter related to the speed of at least part of the bumper or fender, and a signal generator to generate a triggering signal for the safety device if the parameter related to speed is below a first predetermined value.

2. A detector according to Claim 1 wherein the bumper or fender is provided at least one said sensor in the form of an accelerometer to provide a signal representative of the acceleration of the bumper or fender, from which the parameter related to speed is derived.

3. A detector according to Claim 2 wherein two said accelerometers are provided, and averaging means are provided to determine the mean acceleration as measured by the two accelerometers.

4. A detector according to Claim 2 or 3 wherein the parameter related to speed of the bumper is calculated as an integral of the signal from the accelerometer or averaging means.

5. A detector according to any one of the preceding Claims wherein the parameter related to speed which is compared with the first predetermined value is the maximum speed that is measured during a predetermined period of time following the sensing of an impact.

6. A detector according to any one of Claims 1 to 4 wherein the parameter related to speed which is compared with the first predetermined value is the speed that is measured at the end of a predetermined period of time following the sensing of an impact.

7. A detector according to Claim 5 or 6 wherein the said predetermined period of time is approximately 30 ms.

8. A detector according to any one of the preceding Claims wherein the triggering signal is generated when the parameter related to speed value is below the first predetermined value, but above a second predetermined value.

9. A detector according to any one of the preceding Claims wherein the first predetermined value is dependent upon the instantaneous measured velocity of the vehicle, there being means to determine the velocity of the vehicle, and to calculate the first predetermined value from the determined vehicle velocity

10. A detector according to any one of the preceding Claims wherein there are means to determine the speed of the vehicle and to inhibit generation of the triggering signal if the vehicle speed is below a predetermined value.

11. A detector according to Claim 10 wherein the predetermined speed value is 20 km/h.

12. A detector according to any one of the preceding Claims wherein the bumper or fender is provided with a contact strip sensitive to impact with an object to generate a contact signal to initiate operation of the signal generator.

13. A detector according to Claim 12 wherein the contact strip is responsive to the width of the part of an impacting object contacting the contact strip, and the detector is such that if the width of the object exceeds a predetermined threshold, generation of the triggering signal is inhibited.

14. A detector according to any one of the preceding Claims wherein the detector incorporates a calculator to determine the parameter related to speed by calculating the integral of the acceleration of the bumper or fender relative to the acceleration of the vehicle.

15. A detector according to claim 14 wherein the bumper has a said sensor in the form of an accelerometer and the vehicle has an accelerometer, the outputs of the accelerometers being subtracted and integrated.

16. A detector according to claim 14 wherein the bumper has a said sensor in the form of an accelerometer and a memory to store the instantaneous acceleration which is fixed in the event of an impact, the outputs of the accelerometer and the memory being subtracted and integrated.

17. A detector according to any one of Claims 1 to 13 wherein the parameter related to speed is derived from a sensor responsive to the relative speed between the bumper or fender and the chassis of the vehicle.

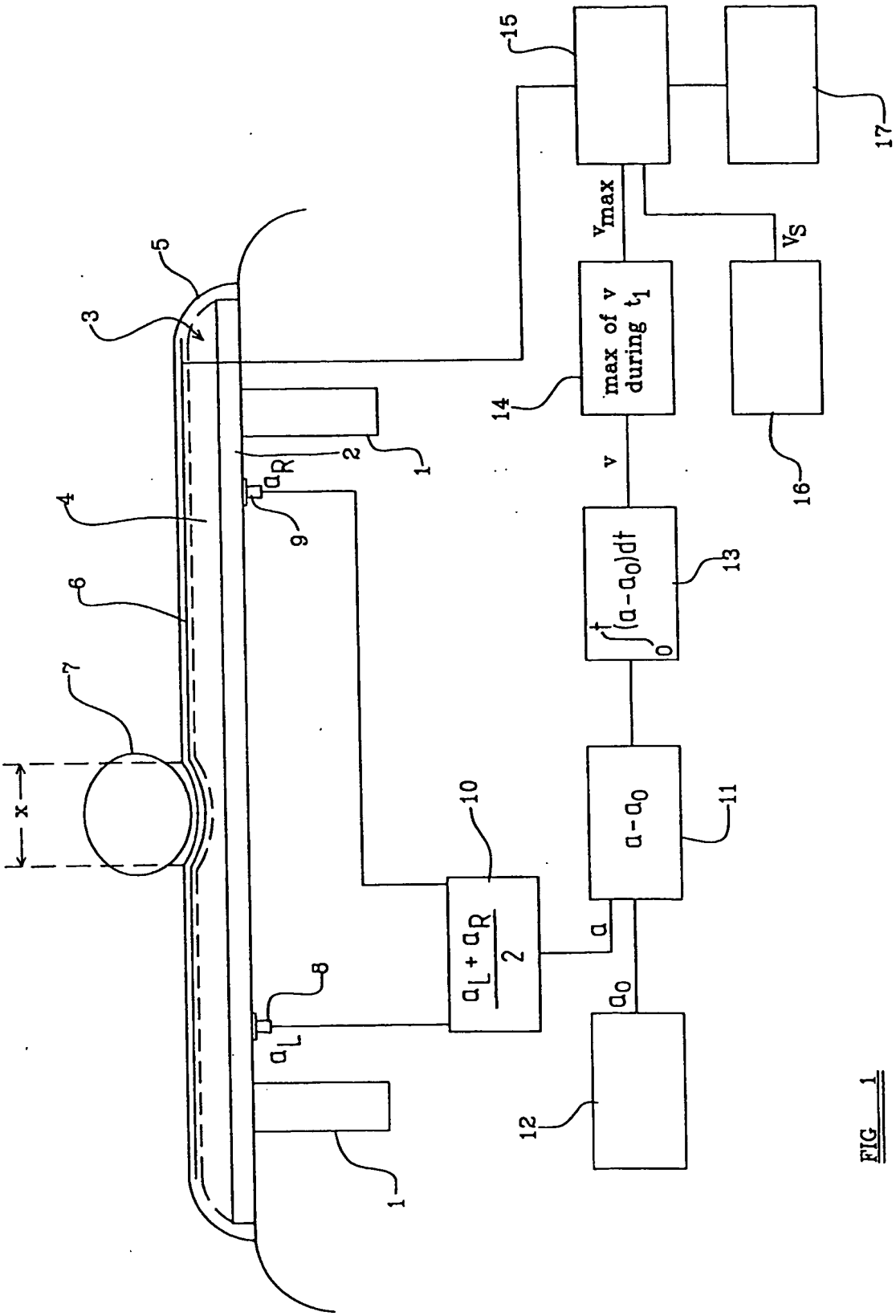
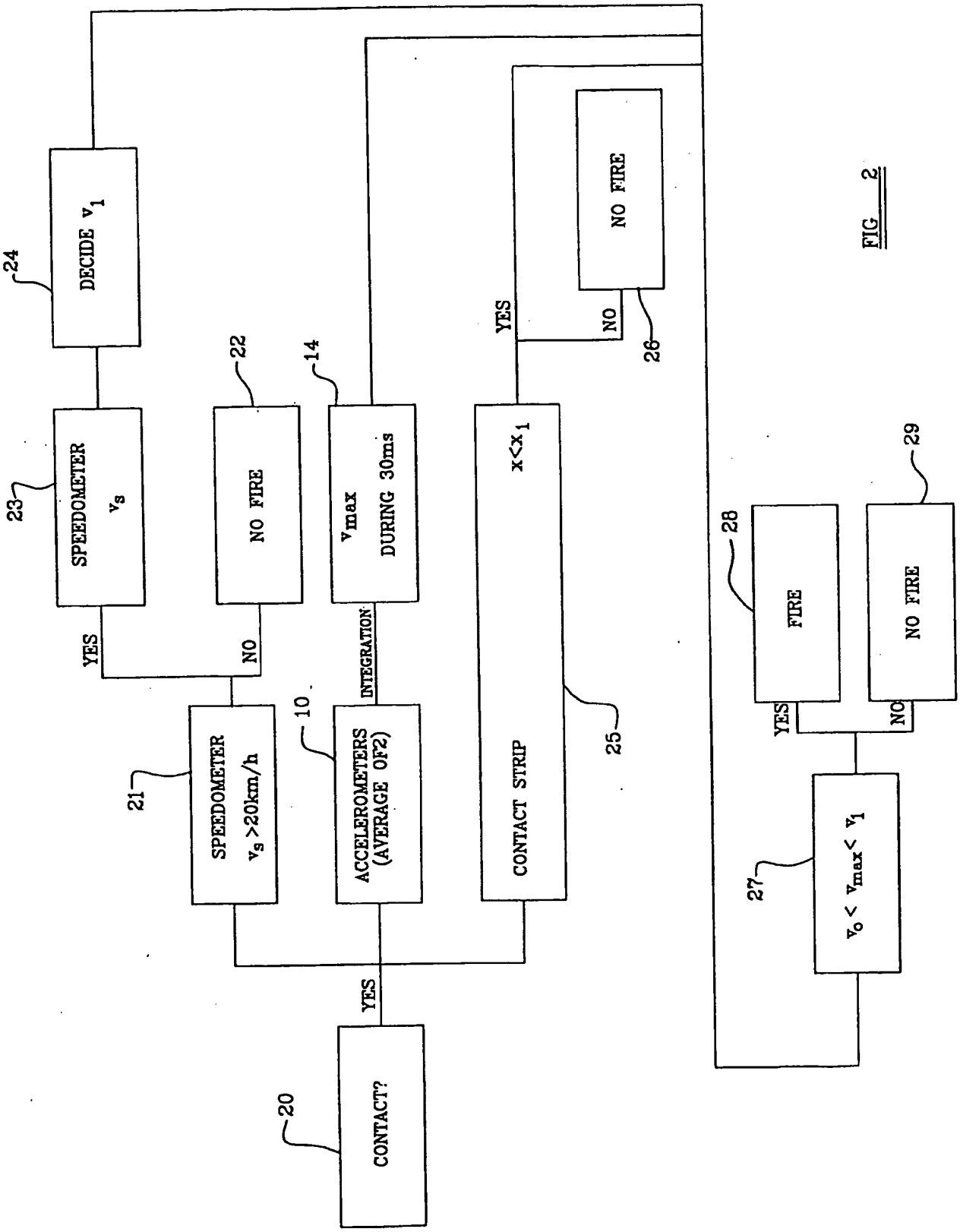

15
17
v_{max}
v_S
5
3
max of v during t_1
14
16
1
2
a_R
4
9
v
$\int_0^t (a-a_0)dt$
13
6
7
x
10
$a-a_0$
11
$\frac{a_L+a_R}{2}$
a
8
a_0
a_L
12
1

FIG 1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24
SPEEDOMETER v_s
23
YES
NO
NO FIRE
22
v_{max} DURING 30ms
14
INTEGRATION
$x<x_1$
CONTACT STRIP
25
YES
NO
NO FIRE
26
FIRE
28
NO FIRE
29
YES
NO
$v_0 < v_{max} < v_1$
27
SPEEDOMETER v_s >20km/h
21
ACCELEROMETERS (AVERAGE OF2)
10
YES
CONTACT?
20

FIG 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/01030

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60R 21/34
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10045698 A1 (HONDA GIKEN KOGYO K.K.), 17 May 2001 (17.05.01), column 5, line 58 - column 6, line 66, figure 1	1-17
A	EP 0937612 A2 (KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO), 25 August 1999 (25.08.99), figures 1,2, abstract	1-17
A	EP 0914992 A1 (NISSAN MOTOR CO., LTD.), 12 May 1999 (12.05.99), figure 1, abstract	1-17

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2002	09 -09- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bertil Nordenberg/MN Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 02/01030

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10045698 A1	17/05/01	JP 2001080545 A	27/03/01
		JP 2001080454 A	27/03/01
EP 0937612 A2	25/08/99	JP 11310095 A	09/11/99
		JP 2000177514 A	27/06/00
EP 0914992 A1	12/05/99	DE 69805589 D	00/00/00
		JP 11142422 A	28/05/99
		US 6332115 B	18/12/01